Center Innovation Fund: ARC CIF

New Stagnation Arc Jet Model Design for Testing ADEPT 3-D Carbon Cloth

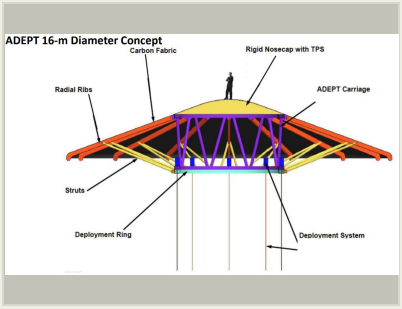
Completed Technology Project (2016 - 2017)

Project Introduction

The test article design will be similar to a graphite "embroidery hoop" holding the fabric between the two cylinders, with insulation materials added to reduce the thermal contact between the high thermal conductivity carbon cloth and the high thermal mass of the graphite. Additional considerations that will feed into the design effort will be instrumentation. The ADEPT design approach takes advantage of the high thermal conductivity and emissivity of the carbon cloth, and the open back allows for much of the energy to be radiated off the back surface. The design will need to allow for determination of the temperatures of both the front and the back surfaces of the cloth, so accommodation of back surface pyrometry will be required. Working with the Human Mars analysis results on the predicted flowfield conditions, we will run simulations of the AHF conditions with varying gas mixtures to define a set of test conditions. With those conditions, we will iterate between design development and thermostructural analysis of the design to insure that the holder and specimen will survive the test environments. Once the design has closed, we will build one or two instrumented prototype AHF test article(s) that will be ready to test. This model will include instrumentation on the holder parts as well as the carbon cloth to verify the thermostructural analysis predictions. Due to the high cost of arc jet testing (~$37K/day), testing is not included in this proposal.

Anticipated Benefits

The Adaptive Deployable Entry and Placement Technology (ADEPT) is being considered as an entry, descent and landing (EDL) system to enable Human Mars class missions. ADEPT is a mechanically deployable decelerator that makes use of a 3 d woven carbon fabric as both heat shield and primary structure. The Human Mars Mission design study is focused, in part, on assessing the viability of ADEPT and identifying technical challenges, operational constraints, and critical risk mitigation activities. To date, the study has found that, while the ADEPT concept has some design challenges, the scalability of the ADEPT system is viable and mass efficient for landing large masses at Mars. One issue found is as the size of the decelerator increases the convective heatflux decreases, along with the monatomic oxygen levels, moving the carbon surface-planetary atmospheric gas system into the kinetic oxidation regime. The current approach utilizes equilibrium thermochemistry to predict the mass loss due to oxidation which is overly conservative and results in a requirement for many more ablative layers than will truly be needed. The thicker the woven TPS structure, the heavier the system is and the more difficult it is to fold and stow



A new stagnation test article has been designed for developing an engineering model representing the mass loss of carbon cloth as a function of the partial pressure of monatomic oxygen for more reasonable predictions of carbon cloth thickness requirements i…

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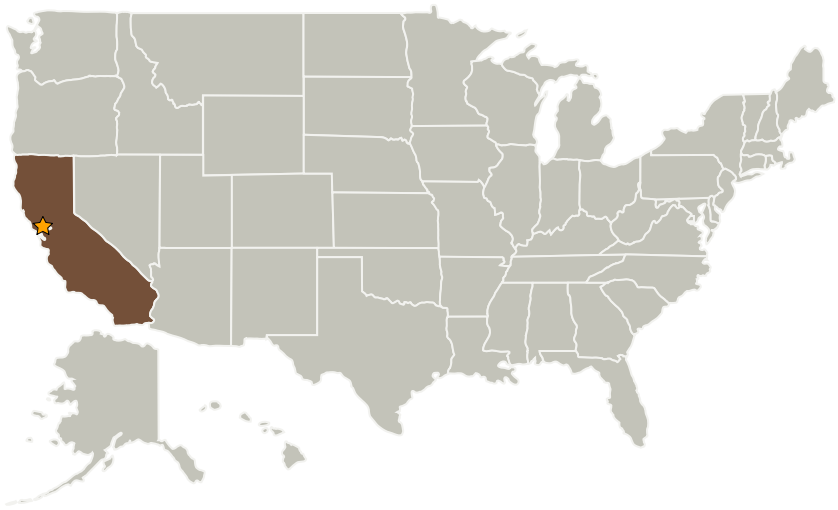
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

Center Innovation Fund: ARC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

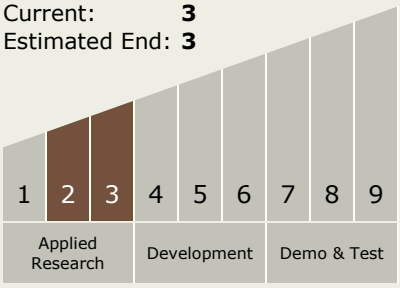
Harry Partridge

Principal Investigator:

John C Beck

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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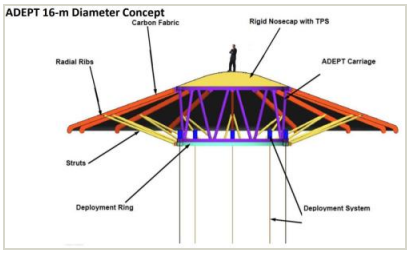
Images



Project Image
A new stagnation test article has been designed for developing an engineering model representing the mass loss of carbon cloth as a function of the partial pressure of monatomic oxygen for more reasonable predictions of carbon cloth thickness requirements in low heating environments *(https://techport.nasa.gov/image/35775)*

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

Target Destination

Mars